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NUCLEONICA:
Mass Activity Calculator

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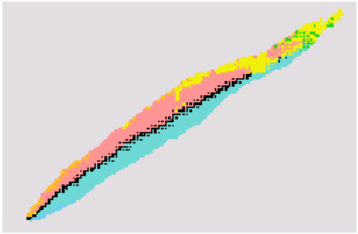
nucleonica

Nuclear science applications…

nucleonica … web driven nuclear science

Applications | My Preferences | Help

Nuclide Explorer



» Actual Chart: Karlsruhe

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Search

Nuclear Data Retrieval

nucleonica [wiki]

Application Centre

- Mass Activity Calculator
- Decay Engine
- Dosimetry & Shielding
- Range & Stopping Power
- webKORIGEN
- Universal Nuclide Chart
- Transport & Packaging
- Nuclide mixtures
- Nucleonica Scripting
- Library creation for 3rd party software
- Radiological Dispersion Module
- Extended Graph Module

Data Centre

- Physical Constants
- Nuclide Datasheets
- Nuclide Derived Data
- Average Cross Sections
- Radiations
- Prompt Gamma
- Fission Yields

Knowledge Centre

- Nuclear News
- Reading room
- Useful Weblinks
- Ask An Expert
- Element Information
- Conference Calendar

Welcome, Joe

Edit Preferences | Administration

MyCommunity Portal

My Last Nuclides

- 90 Th232
- 90 Th231
- 94 Pu239
- 92 U235
- 25 Mn52

My Nuclide Mixtures

- Pu238+daughter (100g @50y)
- Natural Uranium
- Cs137 + Ba137m
- U232+Co60
- Transuranics in 1 ton Spent Fuel (4.2% enriched, 50GWd/t, 6 years cooling)

My Sources

- Pu239 1 g
- natu

My Messages

- Thanks!
- About my group and information
- Photo Change
- Open call for JRC Traineeships at the Institute for Transuranium Elements
- NAMLS-9 International Conference on Nuclear Analytical Methods in the Life Sciences

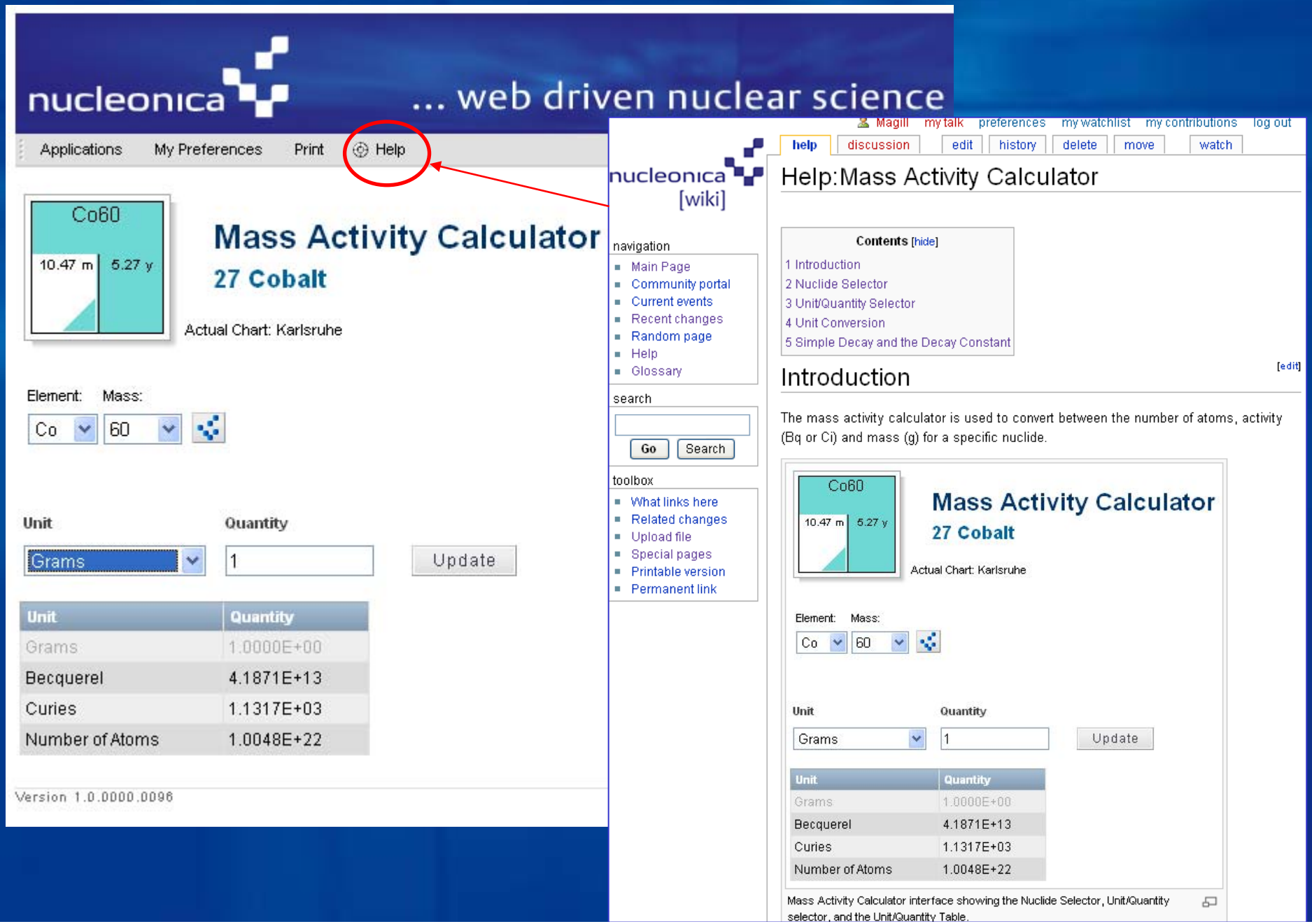
» View

User Alerts

- Task completed (DecayEngine: Uranium 238)

» View

Example of a simple NUCLEONICA application: The Mass-Activity Calculator



Example of a simple NUCLEONICA application:

The Mass-Activity Calculator:

Unit Conversion [edit]

The conversion from mass to number of atoms N, and vice versa, is obtained using

$$N = Mass(g) \cdot N_A/M$$

where N_A is Avogadro's number, M is the atomic mass of the nuclide. The conversion from number of atoms to activity, and vice versa, is obtained using

$$Activity(Bq) = k \cdot N = ln2 \cdot N/\tau$$

$$Activity(Ci) = Activity(Bq)/3.7 \cdot 10^{10}$$

where k, and τ are the decay constant and half-life respectively of the nuclide. It follows that the relation between activity and mass is given by

$$Activity(Bq) = (ln2/\tau) \cdot Mass(g) \cdot N_A/M$$

Simple Decay and the Decay Constant [edit]

For simple radioactive decay processes in which a parent nuclide decays and there is no source term for the production of the parent, the equation for radioactive decay is given by:

$$dN/dt = -kN$$

where N is the number of atoms at time t and k is the decay constant. The Activity is the number of disintegrations per unit time i.e. $Activity = -dN/dt = kN$. The decay constant is related to the half-life τ through the relation

$$k = ln2/\tau \approx 0.693/\tau$$

It follows that the number of atoms as a fuction of time is given by

$N(t) = N(0) \cdot e^{-kt}$ or alternatively $N = N(0) \cdot \left(\frac{1}{2}\right)^{t/\tau}$

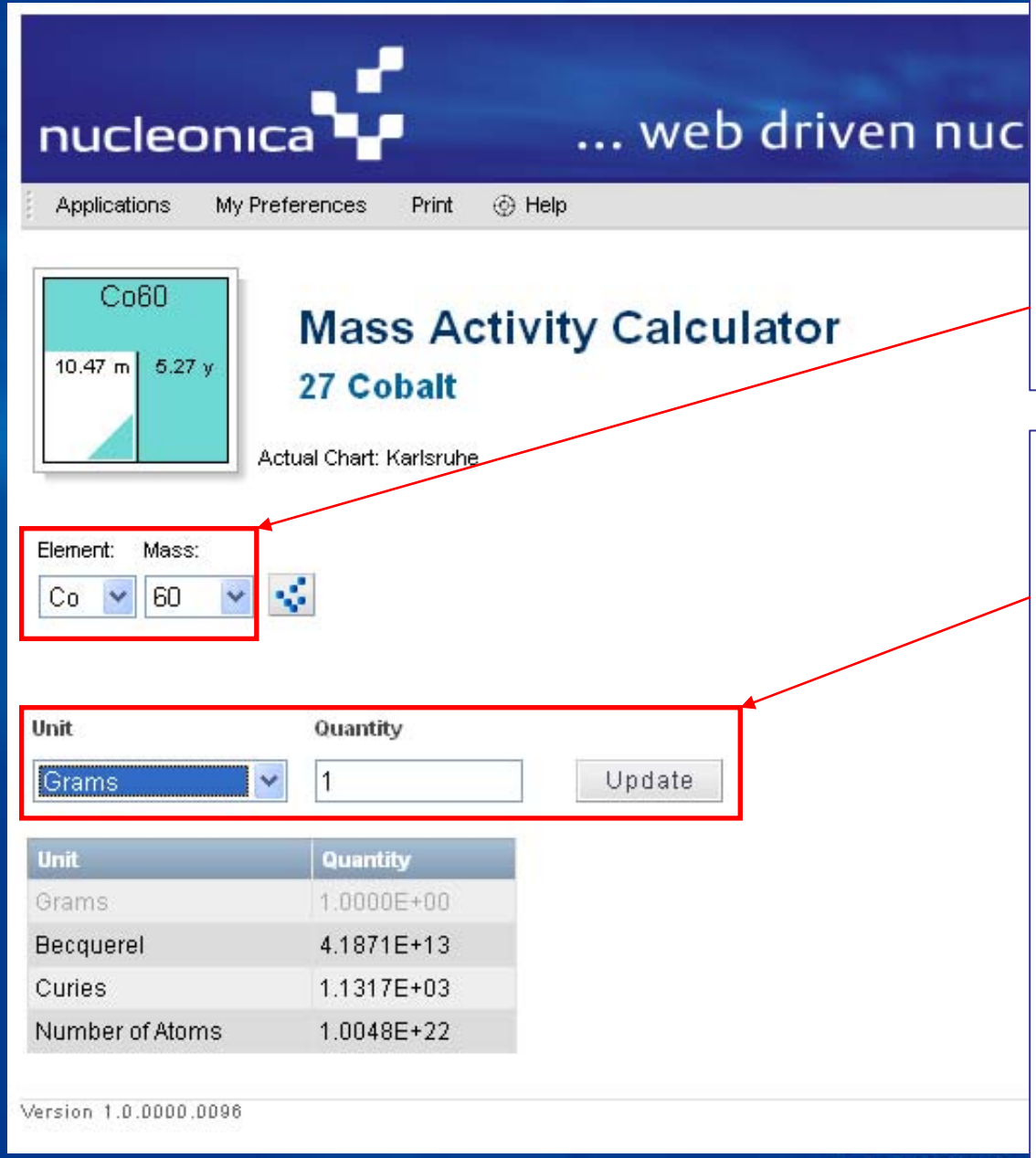
and the activity as a function of time is given by

$Activity(t) = Activity(0) \cdot e^{-kt}$ or altrnatively

$Activity(t) = Activity(0) \cdot \left(\frac{1}{2}\right)^{t/\tau}$

The expressions involving the term $\left(\frac{1}{2}\right)^{t/\tau}$ are useful for calculating directly with the decay time t and the half-life τ.

Example of simple NUCLEONICA application:



Nuclide Selector

[edit]

In the Mass Activity Calculator, the nuclide Co-60 is selected by default. A different nuclide can be selected from the element and mass drop-down menus. The default source strength is 1 gram. In the Unit/Quantity table, this source strength is shown in Becquerel (Bq), Curie (Ci), Number of Atoms. Hence 1 g Co-60 corresponds to a source strength of 4.187E13 Bq, 1.132E3 Ci or 1.005E22 atoms.

Element: Mass:

Co 60

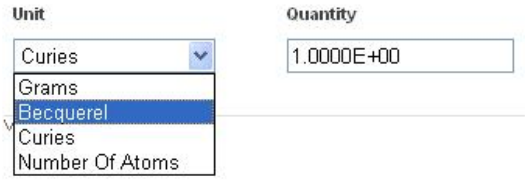
Nuclide Chart Button:

shows the location of the selected nuclide on the nuclide chart.

Unit/Quantity Selector

[edit]

The input unit can be changed in the Unit drop down menu. The default value is 1 gram. Had the value 1 Curie been selected, on pressing the Update button, the corresponding values in grams, Bq, number of atoms are shown in the Unit/Quantity table.



Unit/Quantity Table

Once the unit and quantity have been selected in the Unit/Quantity Selector, the source strength in other units is given in the Unit/Quantity table, by pressing the update button. In the table below, results are shown for 1 Ci Co-60.

Unit	Quantity
Grams	8.8366E-04
Becquerel	3.7000E+10
Curies	1.0000E+00
Number of Atoms	8.8790E+18

Exercises! Mass-Activity Calculator

1. Calculate the specific activities of C-14 and S35? (1.7E11 Bq/g (4.5 Ci/g), 1.6E15 Bq/g (4.3E4 Ci/g)). After what time is the activity reduced by 50% ?(5700 y, 87.32 d)
2. The activity of Sr-90 is 18,000 transformations per minute. What is the mass of Sr-90? (Ans. mass = 5.88E-11g). After what time is the activity reduce to 25% of its initial value? (57.6 y)
3. 6 g of carbon from a piece of wood found in an ancient temple is analyzed and found to have an activity of 10 transformations per minute per gram (from C-14). How many atoms of C-14 are present in the sample and what is their mass? (2.6E11 atoms, mass = 6.0E-12 g)
4. The environmental burden of C-14 is as follows: In the atmosphere 4 MCi, in plants 13 MCi, in the oceans 240 MCi. What are the masses of C-14 in a) the atmosphere b) in plants and c) in the oceans? (893 kg, 2.9 metric tons, 53.6 tonnes)
5. The concentration of potassium (K) in humans is about 1.7 g/kg. How much potassium does an average person (weight 80 kg) contain? (136 g). What is the abundance of K-40 in natural potassium?. What is the mass and activity of K-40 in this person? (0.0117%,1.59E-2 g, 4.2 kBq).
6. Calculate the specific activities of H-3, Sr-90, U-238? (3.6E14 Bq/g, 5.1E12 Bq/g, 1.2E4 Bq/g)
7. What is the maximum alpha particle emission rate from 1 µg Ra-226? (3.7E4 alphas/s)
8. Three hundred MBq (5.4mCi) of Po-210 are required for an ionisation source. What is the mass of Po-210? (1.8 µg)
9. How many grams of Y-90 are in secular equilibrium with 1 mg Sr-90? (0.25 µg)

For further information see our natural radioactivity applet at:

http://www.nucleonica.net/naturalra.aspx

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Thanks!

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